

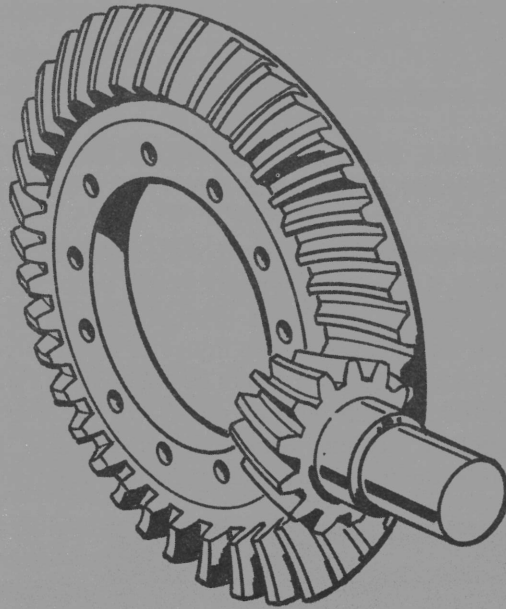
FORM NO. REG01597-02

FOR USE IN SERVICE MANUALS:

M20, M25, MC30 LIFT TRUCKS,

REG01595

M20, M25, MC30 LIFT TRUCKS,
SENB8135

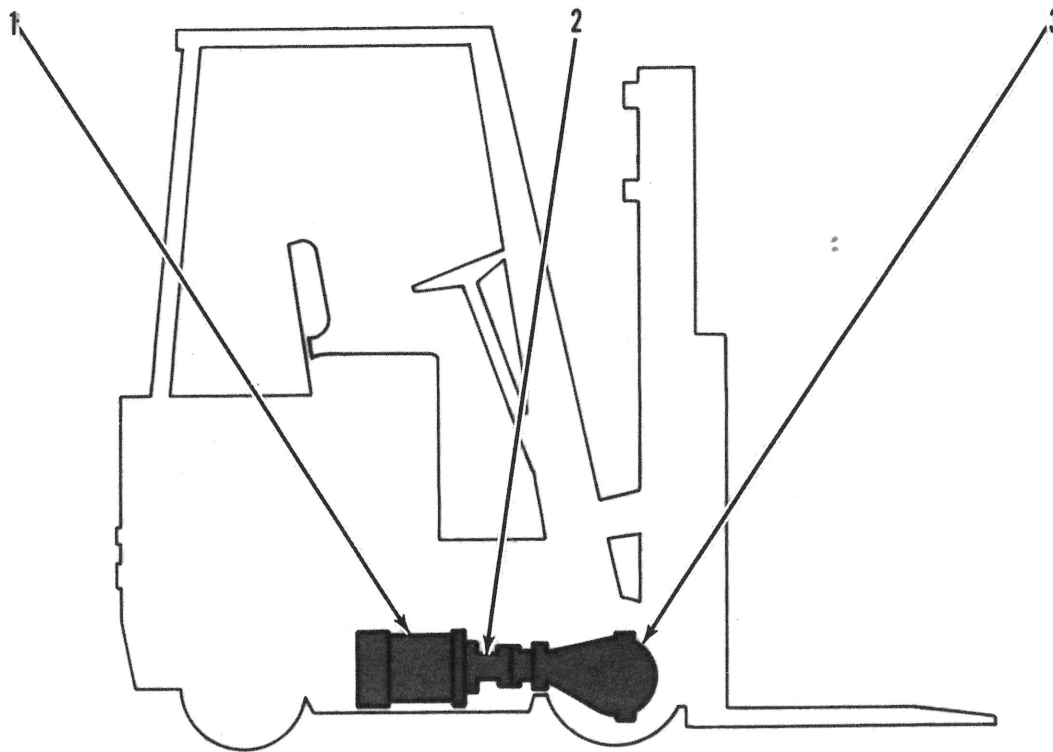


SYSTEMS OPERATION
TESTING AND ADJUSTING
SPECIFICATIONS

M20, M25, MC30 POWER TRAIN

POWER TRAIN

GENERAL INFORMATION



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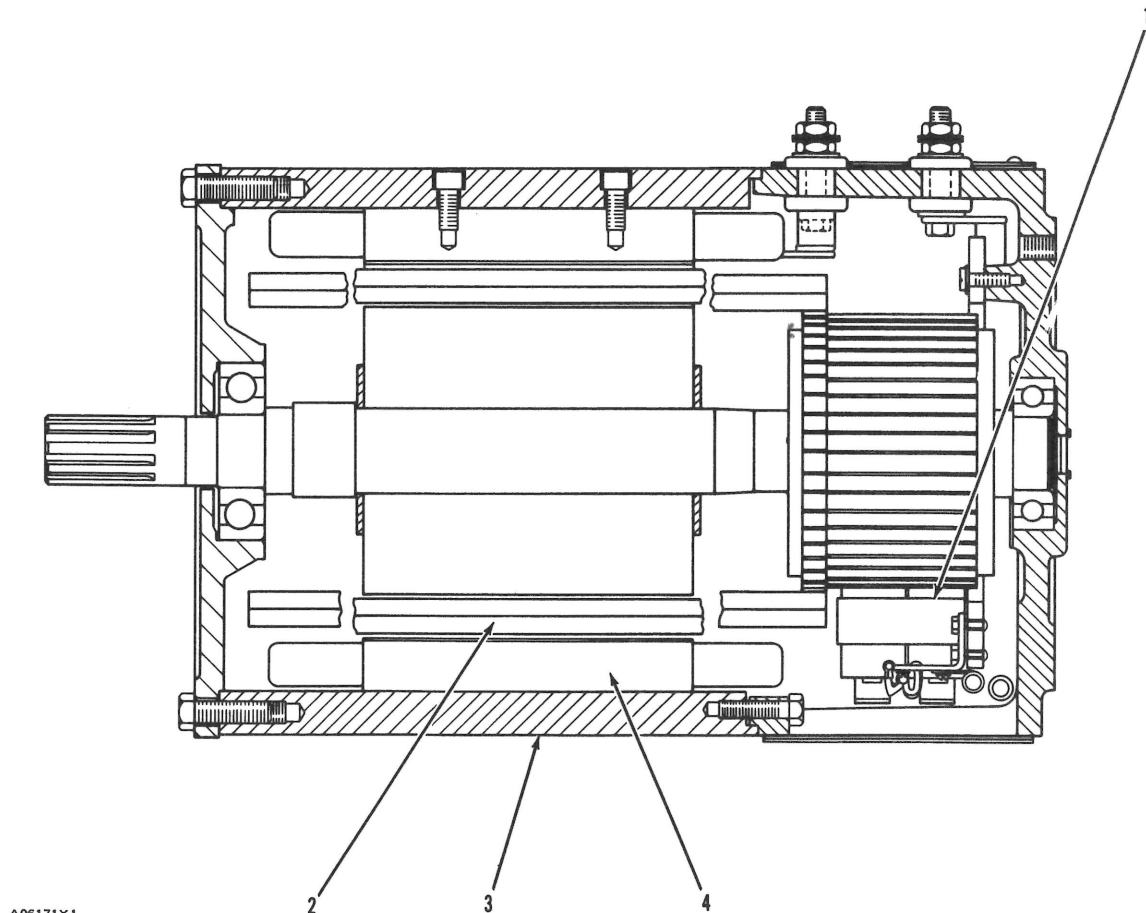
POWER FLOW

1. Drive motor. 2. Universal joint. 3. Differential.

The power train on the M20, M25, and MC30 Lift Trucks has three main components: drive motor (1), universal joint (2), and differential (3).

Electric storage batteries are used as a power source for drive motor (1). The drive motor turns universal joint (2) that is fastened to the input flange of differential (3). The power is sent through universal joint (2) into differential (3). The differential sends power through the axles to the drive wheels.

ELECTRIC DRIVE MOTOR



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ELECTRIC DRIVE MOTOR

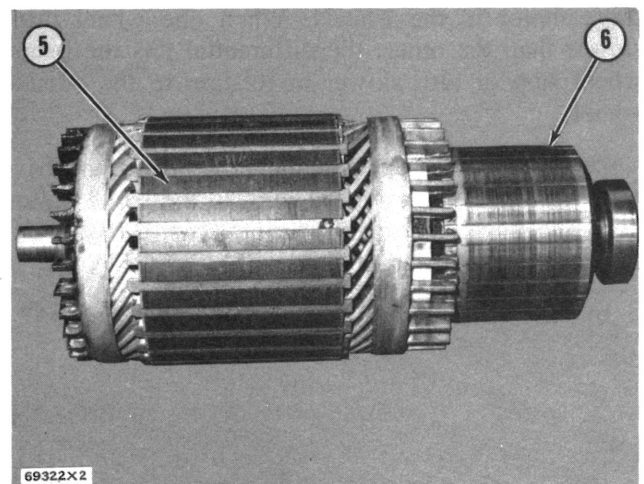
1. Brushes. 2. Armature. 3. Motor frame. 4. Field coils.

The power for the electric lift truck comes from a direct current (DC) motor. The DC motor is a series motor. The motor uses high temperature wire and high temperature insulation to prevent grounds.

Field coils (4) are fastened to the motor frame (3). The power terminals have resistance to corrosion and are located on the outside of motor frame (3). Covers can be removed from the outside of the motor for easy access to brushes (1) and commutator (6).

The motor has four brush assemblies (1), with two brushes in each assembly. Springs hold brushes (1) against commutator (6) to make a compensation for brush wear.

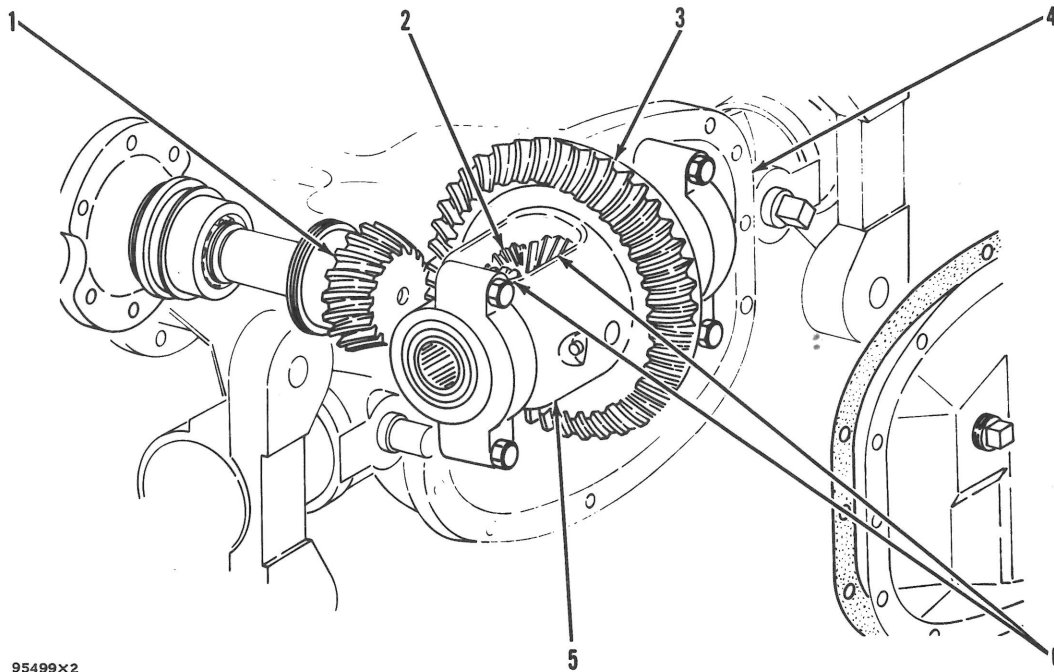
The parts of armature (2) include the shaft, cores (5), windings, and commutator (6).



ARMATURE

5. Cores. 6. Commutator.

SINGLE REDUCTION DIFFERENTIAL AND FINAL DRIVE



95499X2

SINGLE REDUCTION DIFFERENTIAL

1. Bevel pinion. 2. Differential pinion gear. 3. Ring gear. 4. Carrier. 5. Differential case. 6. Side gear.

SINGLE REDUCTION DIFFERENTIAL

The location of the differential is on the front of the lift truck. It is a single reduction unit with a bevel pinion that engages a ring gear fastened on the differential case.

The differential is used to send the power from the drive motor to the wheels. When one wheel turns slower than the other, the differential lets the inside wheel stop or turn slower in relation to the outside wheel.

Power to drive the differential comes from the drive motor through the universal joint to the bevel pinion (1). The bevel pinion turns ring gear (3) which is fastened to the differential case (5).

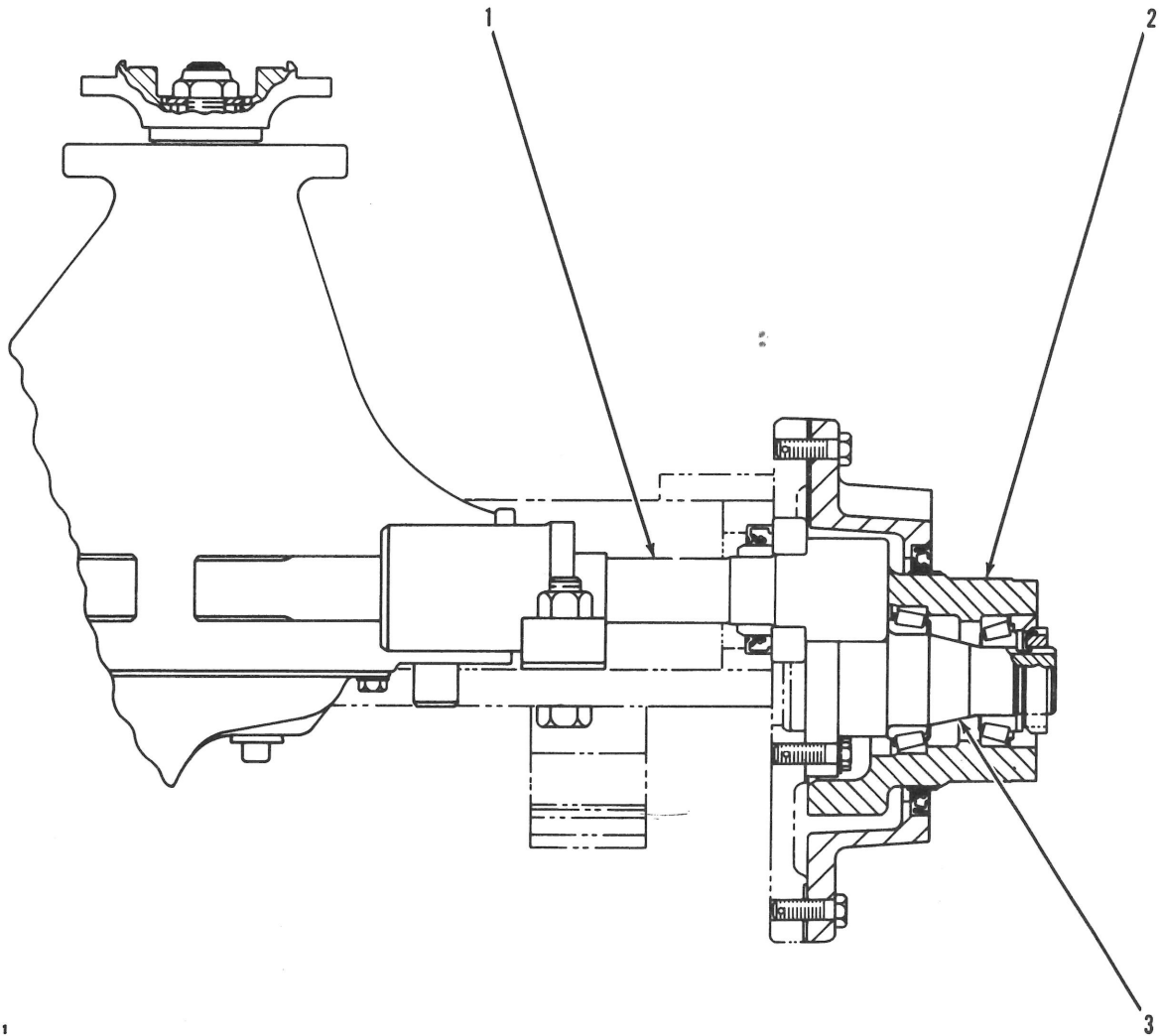
In case (5) are two differential pinion gears (2),

installed on the differential pinion shaft. The pinion gears are engaged with two side gears (6). The side gears have internal splines that turn the axle shafts.

When the truck moves straight in a forward direction and there is the same traction under each wheel, the same torque that is sent to each axle stops pinion gears (2) so they can not turn. This gives the same effect as if both wheels were on the same axle. When the force that is sent to the axles is not the same, as in a turn, forces that are not the same are put on opposite sides of the differential. This action makes pinion gears (2) turn. The rotation of pinion gears (2) stops or slows the inside wheel and makes the outside wheel go faster. This moves the machine through a turn under full power.

The differential gets lubrication from oil thrown about inside the housing.

FINAL DRIVE



A05415X1

FINAL DRIVE

1. Axle shaft. 2. Hub. 3. Spindle.

The differential turns axle shaft (1). The gear teeth on the end of axle shaft (1) engage the gear teeth of hub (2). The gear teeth of hub (2) are on the outside diameter, which causes the rotation of

the hub to be in the opposite direction than the axle shaft. The reduction in size between the axle shaft and the hub causes the hub to turn at a slower speed.

C

TROUBLESHOOTING

CHECKS DURING OPERATION

Make a visual inspection of the truck to check for problems. Operate the truck in each direction. Make a note of noises that are not normal and find

their source. If the operation is not correct, make reference to the Check List During Operation for "problems" and "probable causes".

CHECK LIST DURING OPERATION

ELECTRIC DRIVE MOTOR

Before an analysis is made of any electric drive motor problem, always make reference to the Troubleshooting section of one of the modules that follow: 36/48 Volt M20, M25, MC30 SCR Control System module, Form No. REG01596; or for serial numbers 41W792-UP, 36/48 Volt M20, M25, MC30 SCR Control System module, Form No. SENB8059.

WARNING

If an electrical failure or an overload of the motor is present, especially in an EE drive motor (closed covered motor), personnel must not breathe the toxic fumes which are a product of the burnt insulation. All power must be disconnected from the motor before any inspection is made to find the failure. The area around the motor must be well ventilated (air flow) and the motor is to be cooled before any repair work is done. Water must not be used on any electrical equipment because of the danger of electrical shock. If a fire is present, disconnect the electrical power and use a carbon dioxide extinguisher to put the flame out.

Do not operate the drive motor without a load as too much speed may cause damage to the motor and injury to personnel.

PROBLEM: Motor will not operate.

PROBABLE CAUSE:

1. Switch not closed (battery connector, key-switch, seat switch, accelerator start switch or direction switch).
2. Bad connections. Fuse bad.
3. Low battery voltage.

CORRECTION:

Close the switch. If it still does not operate, test for power to the control panel and power flow through each switch with a voltmeter.

Check battery connections. Check connections at battery connector. Check the power fuse and control panel fuse. Replace either fuse if bad.

Check the traction motor for possible reasons of a bad fuse. Some causes are:

- a. Operation during too heavy SCR load, too high current limit C/L.
- b. Operation in stall conditions.
- c. Possibly a short circuit in drive motor, see PROBABLE CAUSES 5, 6 and 7.

Check battery terminal voltage. If too low, charge the battery.

Check all the cells for one or more that have defects.

Check the specific gravity of each cell. The maximum density difference from the highest to lowest cell must not be more than .020 SG (specific gravity).

4. Control panel operation not correct.

5. Brushes are worn.

6. Check for opens in the field coils.

7. Check for a short circuit in the armature windings.

See LIFT TRUCK TECHNICAL BULLETIN dated December 21, 1977, Form No. SEBD7067 and article Battery page 26.

See the correct SCR Control System Service module.

Remove the battery, inspect drive motor commutator for burnt marks or scoring (scratches). Make corrections or make a repair of the armature commutator and replace the brushes as necessary.

See Armature Commutator Inspection and Brush Inspection in TESTING AND ADJUSTING.

Make reference to PROBLEM: Sparks at the Commutator and/or Rapid Brush Wear.

Test coils according to procedures in TESTING AND ADJUSTING. If there are opens, make a replacement of the coils.

Loose field winding pole pieces, make the necessary corrections.

Failed armature bar insulation.

Repair or rebuild the insulation or make a replacement of the armature.

PROBLEM: Traction will not operate through a normal work period, but hydraulic operation is normal.

PROBABLE CAUSE:

1. Brakes have a defect, cause a resistance (lack of free movement). Heat increases which causes the motor to stall.
2. Too much heat in SCR control panel because:
 - a. Extra heavy traction loads.
 - b. EE motor panel covers.
 - c. Too high current limit C/L setting.

These can cause SCR insulators to become defective, control panel failure or traction fuse to go bad.

CORRECTION:

Check the brake adjustment according to the procedures in TESTING AND ADJUSTING in the respective Vehicle Systems service module.

Decrease the duty cycle loads.

Remove the EE covers if regulations permits.

Lower the setting of the C/L adjustments.

PROBLEM: Neither traction or hydraulic will last through a complete normal work period.

PROBABLE CAUSE:

1. Too small a battery equipped in the lift truck.

CORRECTION:

Use a larger battery for the complete work cycle and normal work period.

2. Battery not being fully charged or equalized during the battery charging operation.
3. Battery change interval is too long or charged battery cooling time is too short. This decreases the capacity and the ability of the battery.
4. Battery has one or more defective cells which results in less than the rated capacity and ability of the battery.
5. Traction system draws (makes a consumption of) too much battery power because of traction system faults. Operation of the duty cycle (complete working cycle) condition is not correct.
6. Hydraulic system draws too much battery power because of lifting and tilting arrangements, or hydraulic conditions are not correct for the duty cycle.
7. Lift truck working more than the capacity of its design with no available power in one work shift.

Check the battery cells for an equalization charge (a charge to make the specific gravity the same in all cells). Check the battery charger for defects.

Decrease the battery work duration before a change. Increase the battery cooling time after a charge before it is put to use.

Replace the battery.

Change the setting of controlled acceleration C/A rate to decrease power consumption.

Possibly do away with Field Shunt (FS) if lift truck runs at a maximum of 100 ft. (30 meters); or decrease Field Shunt Pick Up (FWPU) setting to increase the distance and time before it is activated during long distance.

Check the brake adjustment according to the procedures in TESTING AND ADJUSTING in the respective Vehicle Systems service module. Check the mechanical components as tie rods, wheel bearings, axles etc. for corrections to eliminate the faults.

Change to a tire with less friction.

Change from the standard differential to a higher gear ratio differential.

Decrease hydraulic relief valve setting to the capacity that only will be used.

Change to a smaller hydraulic motor.

Install tilt limiters.

Check the mast for restriction during operation.

Have available an extra (exchange) battery.

Decrease the speed and work load required to complete the work shift.

PROBLEM: Sparks at the commutator and/or rapid brush wear.

PROBABLE CAUSE:

1. Worn brushes.
2. Overheating (too much heat) of the traction motor.

CORRECTION

Make a replacement of the brushes and make sure the brushes are seated. See New Brush Installation and Brush Inspection in TESTING AND ADJUSTING.

Check for an overloaded motor or a motor with defects. See Armature Commutator Inspection in TESTING AND ADJUSTING.

3. Defective drive motor.

A. Commutator bars burnt in two or more positions at 180° apart because:

- (1) Armature bars open.
- (2) Motor was stalled against a heavy load while power discharged that caused two bars in contact with the brushes to burn.
- (3) Short circuit in the armature.
- (4) Armature not in balance, out of round, off center or with high commutator bars. This causes the brushes to bounce (move up and down).

B. Dirty motor that has metallic or carbon dust. This dust is a conductor which causes electrical shorts, increase amp draw and decrease drive motor output.

C. Brush movement causes arcing and brush wear.

D. Loose brush leads or motor buss bar connections. Loose cable connections at motor terminals. Results are:

- (1) High resistance and heating.
- (2) Faster brush wear.

E. Wrong grade of brushes installed that are not adaptable to the motor.

Decrease the current limit (C/L) adjustments if set too high. See the respective SCR CONTROL SERVICE MODULE.

Test the plugging rate, if set too short it will cause arcing and wear at the brushes.

The duty cycle is too heavy, change the differential to a higher gear ratio.

If the motor has EE covers and the duty cycle is heavy, install external (outer) auxiliary cooling to the drive motor.

See Armature Commutator Inspection in TESTING AND ADJUSTING.

Make a replacement of the armature.

CAUTION

Too heavy a load can stall the motor, as a result failure to the drive motor.

See Armature Tests in TESTING AND ADJUSTING.

Make sure the diameter is the same all the way around and is in center line with the shaft.

Remove any dirt with air pressure.

WARNING

Never use air pressure that is more than 30 psi (205 kPa) and make sure the air line is equipped with a water filter.

Check the brush springs for cracks, and overheat signs (blue).

Compare spring force with a new brush spring.

Check the brush holder for oversize (larger size than for brush).

Replace the brush spring if necessary.

Check brushes for tight connections. Replace the brushes if leads are loose in brush material. Check all cable and wire connections for tightness.

Make sure all the brushes are of Caterpillar standards. Do not use other brands of brushes. Possibly original equipped brushes are not the type for heavy duty cycle. Replace them with heavy duty brushes that have Caterpillar recommendations.

- F. Replacement brushes were not seated, the current goes through a small contact area with the commutator. As a result the brush temperature increases. Possibly if the contact area is poor the brushes will destroy in a few service meter hours.
- G. Possibly heavy working condition that causes too much motor heat and rapid brush wear.
- 4. Overload of drive motor such as: towing loads, constant ramp operations, chiseling (hydraulic actions that are not practical) loads and dragging (pull or push loads on the ground) loads.
- 5. Operation in 1A or Field Shunt (FS) under heavy traction when SCR is better adapted to the duty cycle.
- 6. Current limit (C/L) set too high that causes too much current consumption through motor in the SCR range.
- 7. SCR panel control card is not adjusted correctly.
- 8. Drive motor or armature or field windings has a defect that results in high current draw at low torque output.
- 9. Restriction caused by components.

Always seat new brushes when installed, see New Brush Installation in TESTING AND ADJUSTING.

Make a replacement of the brushes and make sure the brushes are seated. See New Brush Installation and Brush Inspection in TESTING AND ADJUSTING.

Possibly install extra heavy duty brushes if available. Check the brush springs for the correct installation and for the correct spring usage. Too strong a spring rate will increase brush wear rate.

Prevent operation in stall conditions. Excessive (too much) duty cycle which increases motor temperatures and rapid brush wear.

Operator training for better working practices.

Change the differential to a higher gear ratio.

Add an auxiliary cooling to the EE drive motor, or if permitted remove the EE motor covers.

Operator training for better working practices.

Change the setting of C/A acceleration rate to decrease power consumption.

Possibly do away with Field Shunt (FS) if lift truck runs at a maximum of 100 ft. (30 meters); or decrease Field Shunt Pick Up (FWPU) setting to increase the distance and time before it is activated during long distances.

Differential change with higher gear ratio.

Larger battery for heavy working demands.

Decrease the current limit (C/L) adjustment to the correct setting, see the respective SCR Control System Service module.

Make correct adjustment to the card as shown in the respective SCR Control System service module.

See Armature Tests and Field Coil And Terminal Tests in TESTING AND ADJUSTING, also see procedures in LIFT TRUCK TECHNICAL BULLETIN dated December 21, 1977.

Correct and make adjustments to wheel brakes and auxiliary brakes that drag.

10. A defect in Field Shunt (FS) circuit, drive motor constantly in FS range which increases traction, drive motor load and amperage consumption.

PROBLEM: Low resistance to ground [battery polarity either positive (+) or negative (-) or a medium voltage is in direct contact with truck frame (body) or drive motor body].

PROBABLE CAUSE:

1. Dirty battery, electrolyte on top of cells and is in contact with the frame. Current flows through battery box which places a voltage on the truck frame.
2. Battery or control panel wire connections in contact to truck frame.
3. Dirty motor.
4. Wet drive motor.

PROBLEM: Commutator surface has groove or extra wear.

PROBABLE CAUSE:

1. Brushes are worn too low, brush wires caused arcing on commutator.
2. Dirty motor; and possibly salt water got inside.
3. Grades of brushes mixed.

Make changes to tires with less restriction.

Make an adjustment to the tie rods that results in too much steer wheel toe in.

Check and correct wheel bearing torques.

Make repairs to the Field Shunt Circuit.

CORRECTION:

Clean off the battery with baking soda and water solution.

Make a continuity test to move the wire from contact.

Remove wires in sequence until the fault is cleared. The fault will be in the wire last disconnected.

Remove the metallic or carbon dust with air pressure.

⚠ WARNING

Never use air pressure that is more than 30 psi (205 kPa) and make sure the air line is equipped with a water filter.

To dry the motor, heat it to 194° F (90° C).

CORRECTION:

Replace the brushes. See Brush Inspection in TESTING AND ADJUSTING and the method to make the Brush Life Estimate in TESTING AND ADJUSTING.

Disassemble motor, remove the debris with air pressure. If necessary dry the motor with heat to 194° F (90° C).

⚠ WARNING

Never use air pressure that is more than 30 psi (205 kPa) and make sure the air line is equipped with a water filter.

Make sure all the brushes are of Caterpillar standards. Do not use other brands of brushes.

4. Plugging distance set too short. There is no fuse in the plugging circuit. Too short a distance at top speed (1A speed) causes current to circulate back through the circuit. The current rate will be twice or more than the current limit rating which causes too much sparking and rapid brush wear.

Set the plugging distance according to the respective SCR Control System service module.

PROBLEM: Lift truck moves faster in one direction than the other direction with the same amount of accelerator pedal movement in 1A or Field Shunt mode (speed).

PROBABLE CAUSE:

1. Motor brushes not located in the correct electrical position (brush neutral settings).

CORRECTION:

If the holes in the brush holder are not extended, make them longer so that brush holder can have a little rotation. When the holder is in the correct position lift truck speed will be the same in both directions. See LIFT TRUCK TECHNICAL BULLETIN, dated December 21, 1977, page 8.

PROBLEM: Lift truck will not get to top speed.

PROBABLE CAUSE:

1. Battery not fully charged or battery has bad cells.
2. A fault either in drive motor, SCR control panel or drive train.

CORRECTION:

Charge the battery. Check for bad cells. Replace the battery if necessary. See LIFT TRUCK TECHNICAL BULLETIN dated December 21, 1977 page 26.

Check lift truck speed in both directions. If SCR control panel needs tune up make adjustments as shown in the respective SCR Control System service module. If the drive motor is in fault, make the tests of the motor components in TESTING AND ADJUSTING.

PROBLEM: Lift truck does not have power on ramps, can not pick up a load off the ground, and has trouble towing trailers.

PROBABLE CAUSE:

1. Current limit C/L set too low.
2. Current limit C/L circuit has a defect.
3. Pick up loads with unpolished (not finished) forks.
4. Lift truck equipped with tires that slip and with poor traction.
5. Lift truck work condition is too heavy.

CORRECTION:

Set current limit C/L to specification in the respective SCR Control Panel module.

Make test to the SCR Control Panel as stated in the respective service module. Repair or replace components as necessary.

Grind the forks to have a lesser resistance working practice.

Install tires that have good traction and recommendation from Caterpillar Tractor Co.

Install a greater reduction differential for reduced power draw and a greater torque available at the wheels.

DIFFERENTIAL**PROBLEM: Constant noise in differential.****PROBABLE CAUSE:**

1. Lubricant not to the specific level.
2. Wrong type of lubricant.
3. Wheel bearings out of adjustment or have a defect.
4. Drive gear and pinion not in adjustment for correct tooth contact.
5. Teeth of drive gear and pinion have damage or wear.
6. Too much or too little pinion to gear clearance (backlash).
7. Loose or worn pinion bearings.
8. Loose or worn side bearings.
9. Noise in the drive wheel reduction components.

PROBLEM: Noise at different intervals.**PROBABLE CAUSE:**

1. Ring gear does not run even.
 - a. Bolts on drive gear not tightened correctly.
 - b. Drive gear has a defect (warped).
2. Loose or broken differential bearings.
3. Failure or not enough lubricant on the drive wheel reduction components.

PROBLEM: Noise on turns only.**PROBABLE CAUSE:**

1. Differential pinion-gears too tight on the spider or the pinion shaft.
2. Side gears tight in differential case.
3. Differential pinion or side gears have a defect.
4. Thrust washers worn or have damage.
5. Too much clearance (backlash) between side gears and pinions.

PROBLEM: Leakage of lubricant.**PROBABLE CAUSE:**

1. Loss through axle shafts.
 - a. Lubricant above specification level.
 - b. Wrong kind of lubricant.
 - c. Restriction of axle housing breather.
 - d. Axle shaft oil seal installed wrong or has damage.
2. Loss at pinion shaft.
 - a. Lubricant above specification level.
 - b. Wrong kind of lubricant.
 - c. Restriction of axle housing breather.
 - d. Pinion oil seal worn or not installed correctly.
 - e. Universal joint flange loose on the pinion shaft.

PROBLEM: Drive wheels do not turn (drive shaft turning).**PROBABLE CAUSE:**

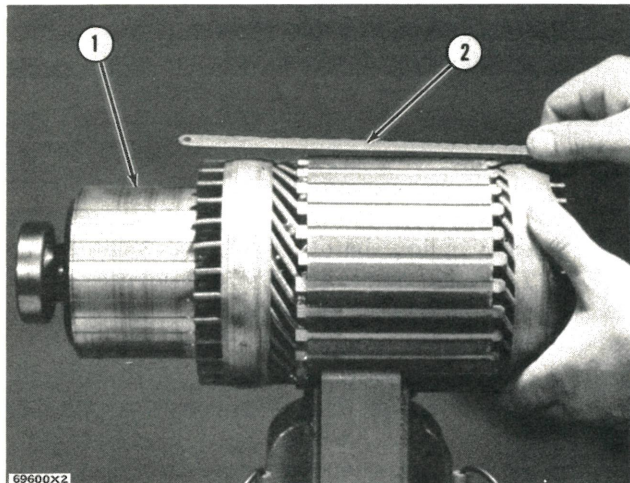
1. Broken axle shaft.
 - a. Loose wheel bearings.
 - b. Axle shaft too short.
 - c. Loose flange studs or nuts.
 - d. Bent housing.
2. Drive gear teeth have damage.
3. Side gear or differential pinion broken.
4. Differential pinion shaft or spider broken.

C

ELECTRIC DRIVE MOTOR

ARMATURE TESTS

Test for Short Circuit

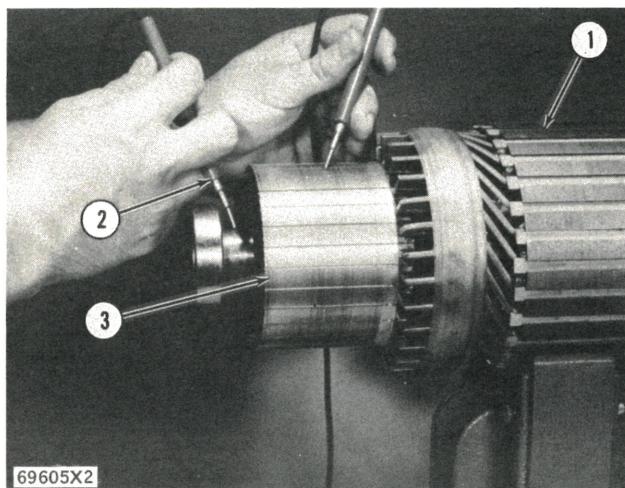


TEST FOR SHORT CIRCUIT
(Typical Example)

1. Armature. 2. Hacksaw blade.

1. Put armature (1) in a growler with the armature windings between the jaw opening of the growler.
2. Turn the growler on and slowly move the armature in rotation on the growler while a hacksaw blade (2) is held directly over the windings.
3. If the windings have a short circuit in them the short circuit will cause a vibration to the hacksaw blade. No vibration will be seen, if the windings do not have a short circuit.

Test For Grounds



TEST FOR GROUNDS
(Typical Example)

1. Armature. 2. Test probes. 3. Commutator bars.

1. Put one test probe (2) on commutator bars (3). Put the other test probe (2) on the armature shaft.
2. If a connection (loop) has a ground, a circuit is complete and causes the light in the growler to show light, or the multimeter will show an indication of low resistance.

NOTE: If a multimeter is used to check the resistance, with the meter setting on RX 10,000 there will be an indication of one megohm or higher. An indication less than one megohm shows that there is a ground.

If there are any short circuits, open circuits or grounds, the armature will have to be rebuilt or a replacement must be made.

Test for Open Circuit

If the electric motor has an open circuit, two badly burned areas will normally be found on the commutator. These burnt areas occur in pairs (located opposite each other) on the commutator. This burnt condition will cause very rapid brush wear.

To check for an open circuit, an instrument is needed that measures low resistance (such as a Kelvin bridge).

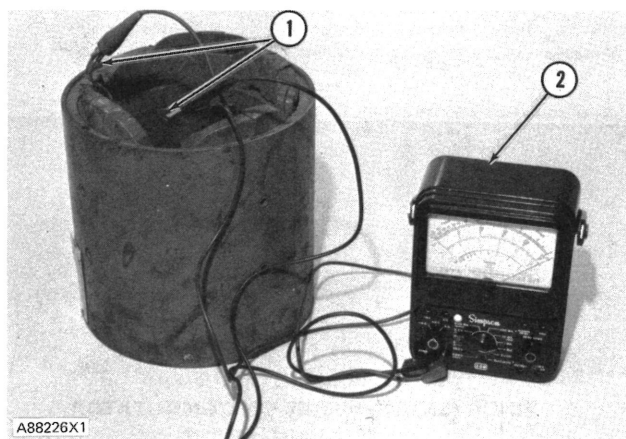
1. Check the resistance between one commutator bar and the bar next to it.
2. Check the resistance in this way between all the sets of commutator bars.
3. There must not be a difference of more than 20% between any of the resistance indications.

If one of the resistance indications is more than 20% greater than the others, there is an open circuit in the armature. This problem will not be corrected when the commutator is machined. The armature must be replaced.

NOTE: Commutator burnt marks can also be caused by excessive loads and too high current consumption on the motor. The motor in this condition cannot turn and the commutator damage looks the same as armature opens. The commutator damage is that the hardened copper becomes soft. Just machining the commutator will not stop the fault from occurring again. The armature must be replaced.

FIELD COIL AND TERMINAL TESTS

Test for Open Circuits

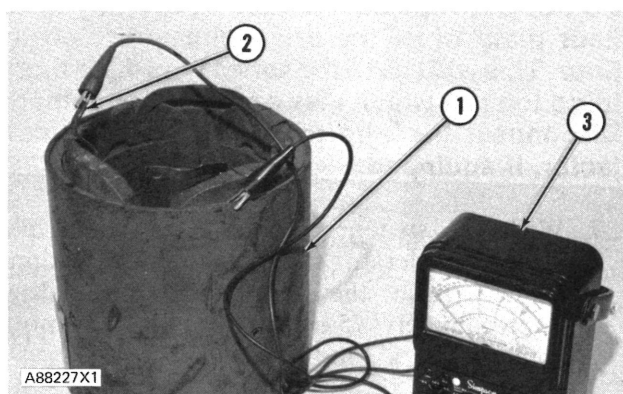


TEST FOR OPEN CIRCUITS

1. Metal connectors. 2. Meter.

1. Make a setting to volt and ohm meter (VOM) (2) to the RXI resistance scale.
2. Connect volt and ohm meter test leads to metal connectors (1) and check the indication of the meter.
3. If the meter indication is more than one ohm, the resistance of the field is too high. This is an indication that the field coils have an open circuit or the connections have corrosion on them.

Test For Grounds



TEST FOR GROUNDS

1. Motor case. 2. Metal connector. 3. Meter

1. Make a setting on meter (3) to the RX 10,000 resistance scale.
2. Connect meter (3) between metal connector (2) and motor case (1). Any indication less than one megohm is an indication of a ground.

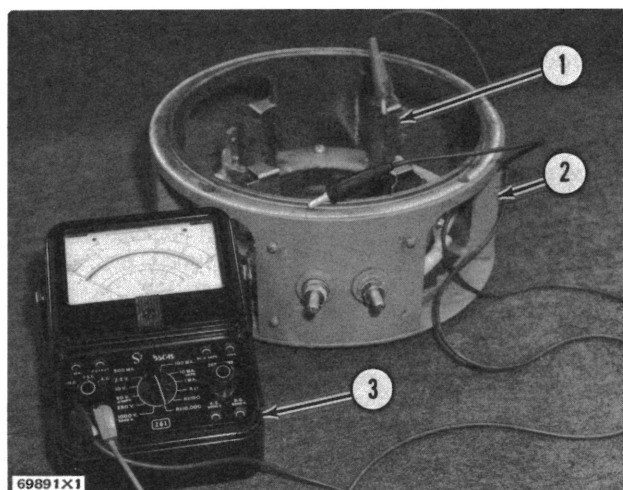
This ground may be caused by wet insulation on the field coils. To make the insulation dry, heat the motor at 194° F (90° C) until the insulation resistance goes up above one megohm and becomes practically constant.

If the ground was not removed when the motor was heated or when the dust and dirt was removed by the use of air pressure, then the field coils will have to be removed and a replacement made.

NOTE: The motor coils can be rebuilt by a good motor rebuilder.

BRUSH HOLDER TEST

A Check for Grounds to Commutator End Frame



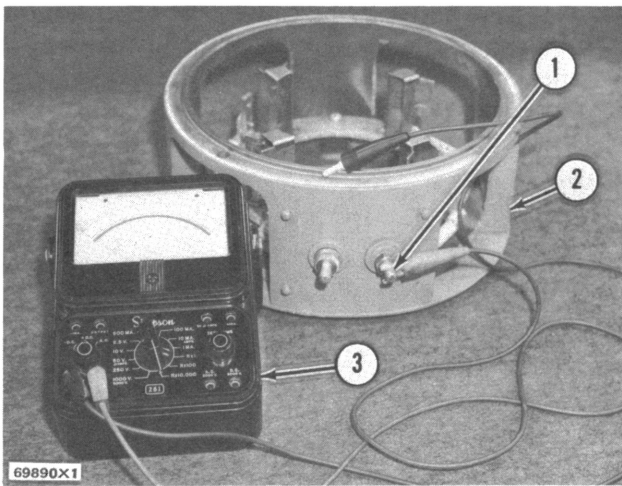
A CHECK FOR GROUNDS TO COMMUTATOR END FRAME (Typical Example)

1. Brush holders. 2. Commutator end frame. 3. Meter.

1. Make a setting to meter (3) to RX 10,000 on the resistance scale.
2. Connect the meter between the brush holders (1) and commutator end frame (2). The indication must show infinity.

A Check of the Terminal Insulation for Grounds to the Commutator End Frame

1. Make a setting to meter (3), to RX 10,000 on the resistance scale.
2. Connect the meter between terminal (1) and commutator end frame (2). The indication on the meter is to show one megohm or more.

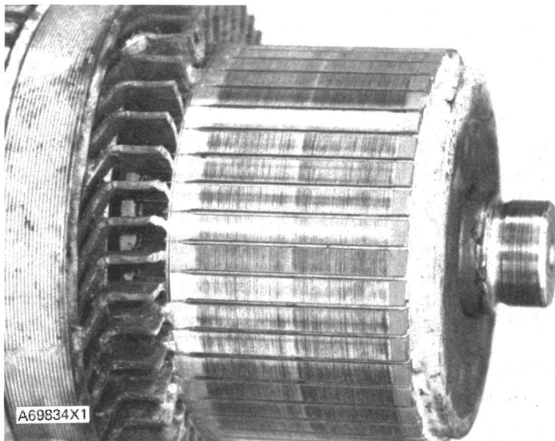


**A CHECK FOR GROUNDS TO THE
COMMUTATOR END FRAME**
(Typical Example)

1. Terminal. 2. Commutator end frame. 3. Meter.

ARMATURE COMMUTATOR INSPECTION

On the surface of the commutator there must be a light (straw color) or dark (black) skin (cover) which is needed as a lubricant. The skin lets the brushes slide over the commutator surface with low friction that gives good brush life.

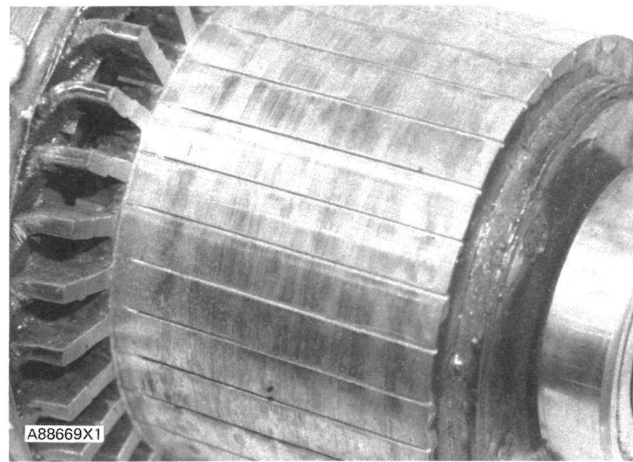


COMMUTATOR SKIN

CAUTION

An abrasive stone of hard material, that is used to seat the new brushes, will remove the skin. When the correct stone, 343337 Brush Seater Stone is used, the brushes are seated and the skin is removed. It takes a few service meter hours for the skin to return to the commutator surface.

If there are some minor (small) marks on the commutator it is possible to remove these marks with the use of the same 343337 Brush Seater Stone. This stone has a medium grit, use it with the new brushes in place as follows:



MINOR (SMALL) MARKS ON COMMUTATOR

1. Disconnect the battery and remove it from the lift truck. Put it on the ground close to the battery connectors of the truck.
2. Use lifting equipment or a method to safely lift the front of the truck until the drive wheels are off the floor. Put the truck on blocks so the drive wheels are free to turn.
3. Remove the covers from the drive motors.
4. Replace the brushes with new brushes if necessary, see Brush Inspection in TESTING AND ADJUSTING.
5. Connect the battery to the battery connector.
6. Put the 343337 Brush Seater Stone on the commutator and operate the motor at a slow speed.

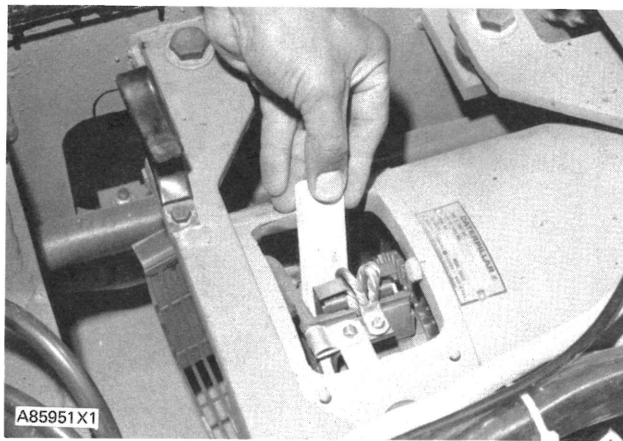
CAUTION

Do not push the accelerator all the way to the floor plate while the drive wheels are off the floor. This will cause the series type drive motor to go too fast which may cause motor damage. Disconnect the wire to the 1A (bypass) contactor, if equipped.

7. With the switches closed (key switch, seat switch, accelerator start switch and directional switch) push the accelerator pedal down approximately .75 in. (20 mm) until the motor rotation has a good speed.
8. Move the 343337 Brush Seater Stone backward and forward across the commutator surface until the commutator marks are gone.

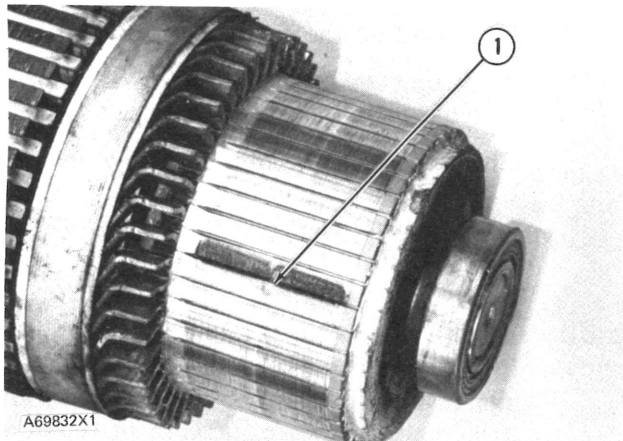
WARNING

When the stone is used, keep hands and feet away from wheels and parts of the armature that move and from the motor brushes.



COMMUTATOR MARKS REMOVAL
(Typical Example)

9. Stop the motor, turn the key switch OFF and rotate the armature by hand. Inspect the commutator surface to make sure all of the surface is good. If the marks are too deep, the armature must be removed and machined.
10. If there are any signs of pitting or pitting on the edges of two bars which are on both sides of the commutator (180° apart), the armature must be replaced.



DAMAGED ARMATURE

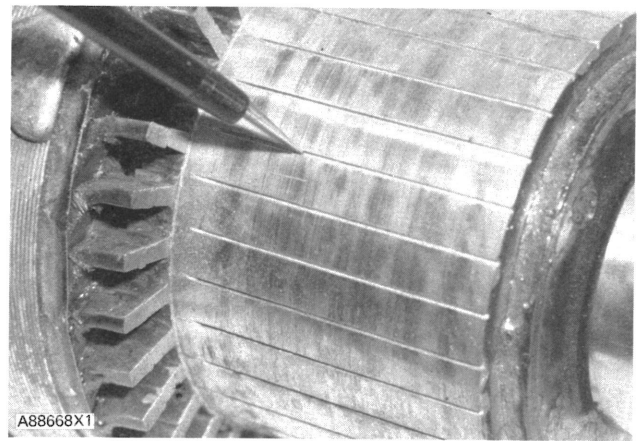
1. Pitting.

Pitting is caused by an open armature bar connection which results in brush wear in only a few smh (service meter hours).

11. Inspect the white or grey mica material between the commutator bars by the rotation of the armature by hand. The mica material must be cut under the surface of the commutator bars. If it is not, the mica can wear the brushes away in less than 15 to 30 smh.

After a commutator has been machined, check the gaps (spaces) between the commutator bars to make sure all of the mica has been cut away.

NOTE: If a repair is made to an armature, or if the armature is changed, install new bearings.



MICA HEIGHT INSPECTION

12. Remove all four brush sets to make sure the new brushes are seated over at least 85% of their surface. If they are not, continue the brush seat operation.
13. After the commutator surface becomes good and all four sets of brushes are seated 85%, operate the motor to remove all dust and abrasive particles with air pressure.

⚠ WARNING

Never use air pressure that is more than 30 psi (205 kPa) and make sure the air line is equipped with a water filter.

RECOMMENDATIONS FOR TEMPERATURE CHECKS

One of the main causes of rapid motor brush wear is excessive (too much) commutator and brush temperature. Check the temperature of the brushes and commutator with the procedures that follow:

1. If a contact type thermometer or thermistor is not available use a Tempil Stik. Tempil Stiks will melt (become a liquid) on contact with a material at or above the temperature marked on the side of the crayon.
2. Stop the motor, turn the key switch OFF.
3. Disconnect the batteries and discharge 1C Capacitor. Remove the battery from the lift truck.
4. Remove the cover from the motor.
5. Touch the armature riser with a Tempil Stik that is rated at 250° F (121° C) and one that is rated at 300° F (149° C). Tempil Stiks are available from 115° F (46° C) and up and in 5° F (3° C) increments (an increase in valve).
6. If the Tempil Stik melts fast at contact on the commutator bar or on the brush, put a higher

temperature rated Tempil Stik in contact. If the next higher Tempil Stik does not melt, the temperature of the material is approximately half way between the two Tempil Stiks.

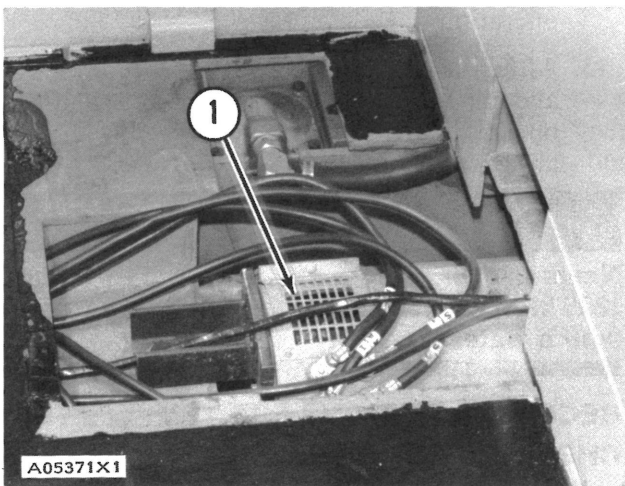
7. The maximum permissible temperature is 270° F (132° C). The temperature of the material contacted with the related temperature rated Tempil Stik can be identified with a white line on the material first and then the Tempil Stik will melt slowly.

CAUTION

Temperatures that are near 270° F (132° C) will rapidly cause damage to the brushes.

NOTE: For causes of high (too much heat) temperatures, see TROUBLESHOOTING.

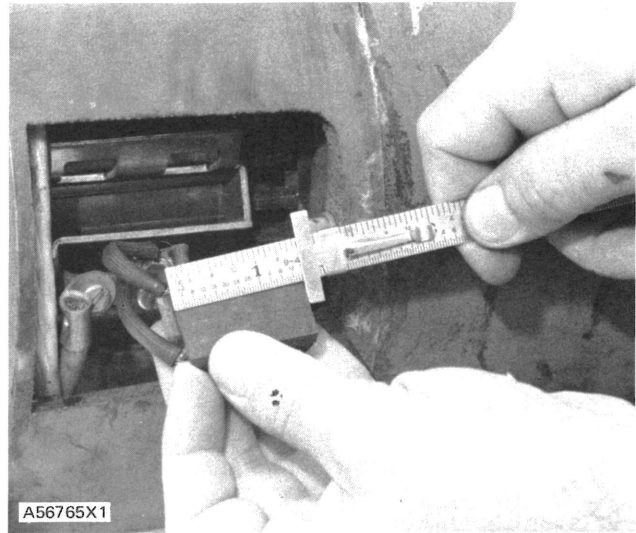
BRUSH INSPECTION



REMOVAL OF THE MOTOR COVERS

1. Cover.

1. Disconnect the battery and remove it from the lift truck.
2. Remove covers (1) from the motor.
3. Remove the springs that hold the brushes in the holders.
4. Remove the brushes and measure the brush on the longest side. If the remainder of the brush material is near or measures less than 1.12 in. (28.5 mm), a replacement of the brush is necessary.
5. The checks and inspections that follow must be made to get better operation of the brushes.
 - A. Check the commutator, see Commutator Inspection, for an open connection. An open connection in the armature can cause a set of brushes to wear out in only a few smh (service meter hours).



MEASUREMENT OF THE BRUSH MATERIAL

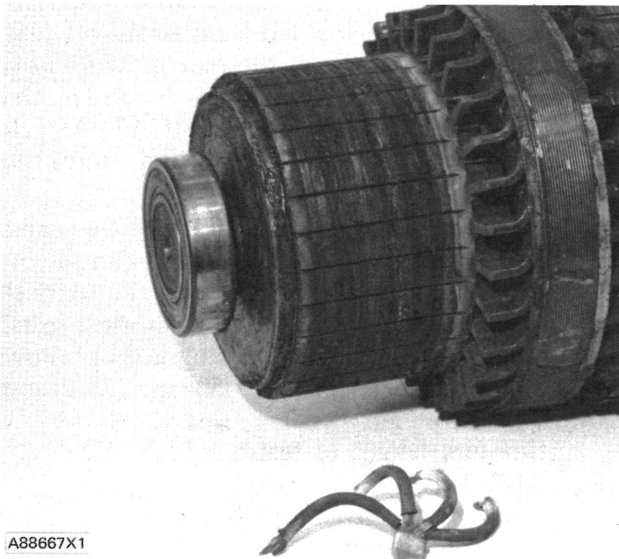
- B. If the brush springs get too hot and become soft, the brushes will not push on the brush correctly. Check for:
 1. Blueing (spring turns blue) of the spring.
 2. Loss of spring force in relation to new springs.
 3. Cracks on the surface of the springs.
 4. Wrong spring installation, the spring must push on top of the brush.
- C. Check the tightness of the field pole screws. If there was contact between the armature and the field poles this can cause a short circuit (armature must rotate freely).
- D. Check the motor cables. A loose cable terminal or a cable with broken wires inside it puts a resistance in series with the motor. The results are a slower motor start up and a large temperature increase in the commutator and brushes.

CAUTION

The brush wear rate increases as the average temperature goes up to a certain maximum. If the brush temperature is higher than a certain specific value (according to the brush design) the brushes will begin to wear very fast or become damaged. The brushes will have a very short life. The glue that holds the brush material together becomes damaged and the brush destroys.

- E. Other factors which have an effect on the brush temperature:
 1. Make sure the battery is not discharged too much.

2. The motor and brushes get hot when the average load is too high. The current consumption and the number of starts are higher than specific limits.
3. The motor is not well ventilated (without air flow) or an enclosed motor EE-type.
4. See Troubleshooting for more factors.



**COMMUTATOR DAMAGE WITH
EXCESSIVE BRUSH WEAR**

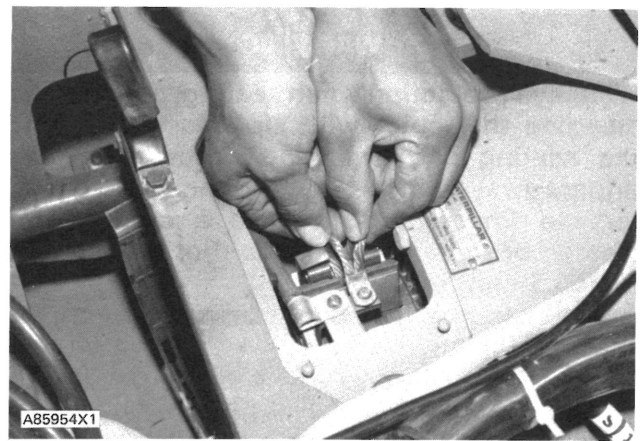
NOTE: Photograph A88667X1 is an indication of too much heat that causes excessive brush wear and sparking (electrical burns) on the commutator.

NEW BRUSH INSTALLATION

1. Disconnect the batteries and remove them from the lift truck. Put them close to the battery connectors on the truck.
2. Use lifting equipment or a method to safely lift the front of the truck until the drive wheels are off the floor. Put the truck on blocks so the drive wheels are free to turn.
3. Remove the covers from the motor and install new brushes and the brush springs.

NOTE: If new brushes are installed on a badly worn commutator or one that has damage, the brushes will have rapid wear.

4. Check to be sure the brushes move freely in the brush box, pull up on the two wires of each brush until the brush moves upward. Release the wires to see if the brush moves back down to the commutator surface. If it is too difficult to pull up the brush or if it sticks (binds) in the box remove the brushes and spring and make corrections to find the cause of the problem.



CHECK BRUSH INSTALLATION
Typical Example

CAUTION

Installation of the wrong brush is one of the fastest ways to cause failure of the motor. Always make sure the correct brushes are installed.

5. Connect the batteries to the battery connector.
6. Put 343337 Brush Seater Stone on the commutator and operate the motor at a slow speed.

CAUTION

Do not push the accelerator all the way to the floor plate while the drive wheels are off the floor. This will cause the motor to go faster than necessary to make a seat.

7. With the switches closed (key switch, seat switch, accelerator start switch and directional switch) push the accelerator down approximately .75 in. (20 mm) until the motor rotation has a good speed.
8. Move stone (2) backward and forward across the commutator, at the back edge of the brushes for a moment or two. This will take the old shine off the commutator and put the brushes in their seat.
9. Operate the motor in the opposite direction and continue to seat the brushes.

CAUTION

Do not let stone (2) be in contact with the commutator too long and cause more wear than necessary.

NOTE: Brushes must be given the correct seat every time they are installed in a motor. This is necessary because the curve needed on the brush to fit the commutator correctly is never exactly the same in different motors and in different brush positions. Continue to seat the brushes with the motor running in the opposite direction.

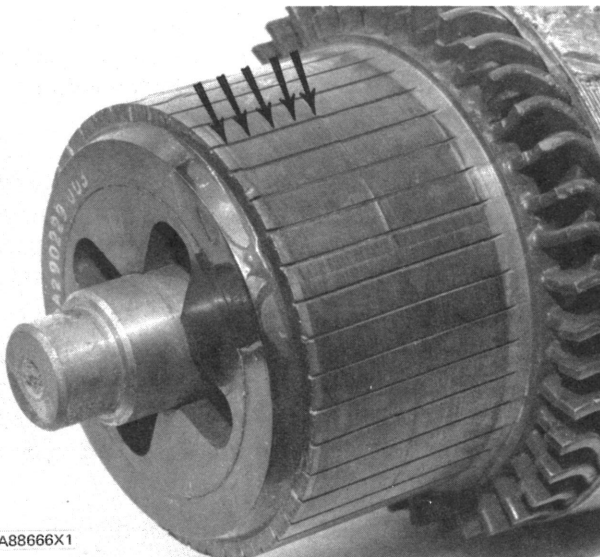
⚠ WARNING

Wear eye protection when seating, polishing or cleaning the motor with air pressure. During the seating and polishing procedure, keep fingers away from the risers. To help prevent injury to fingers, do not use a commutator cleaner or seater stone that is shorter than 2.50 in. (63.5 mm) in length.

10. Stop the motor, turn the key switch off and check the contact surface of all four sets of brushes. About 85% of the brush contact surface must show contact. If necessary do Steps 6 thru 8 again until the correct contact can be seen on the brush contact surface. Check all eight brushes.
11. After the brushes have a correct seat, operate the motor to remove all dust and abrasive grit with air pressure.

⚠ WARNING

Never use air pressure that is more than 30 psi (205 kPa) and make sure the air line is equipped with a water filter.



COMMUTATOR DAMAGE

NOTE: Photograph A88666X1 is an indication of dirt or abrasive grit inside the motor that causes grooves on the commutator surface.

Brush Life Estimate

1. Before installation of new brushes, make an inspection of the armature commutator, see Armature Commutator Inspection in TESTING AND ADJUSTING.
2. Do the steps and procedures for New Brush Installation in TESTING AND ADJUSTING.
3. Make the initial (first) inspection of brush wear

between 250 smh and 500 smh. The reason for this initial inspection is to see if the brush wear rate is normal and not too fast. The measurement will help make an estimate of the length of brush life to be expected.

NOTE: If there is an indication that brush wear is too fast, see TROUBLESHOOTING, PROBLEM: Sparks at the commutator and/or rapid brush wear; for probable cause and corrections to this problem.

4. Inspect all the brushes in the motor, especially the brushes at the left side location, (270° position as seen from the rear of the motor). Measure and record each new brush length in each brush set (see SPECIFICATIONS for each new brush length and minimum brush length).
5. To estimate the number of hours use that can be expected from the brushes that are in the motor, use the measurement taken in Step 3 for the brush that has the most wear (shortest brush) and the procedure in the example that follows:
 Length of new brush 1.50 in. (38.1 mm) [1-8/16].
 Minimum length of brush 1.12 in. (28.5 mm) [1-2/16].
 Total amount of useable brush wear is .38 in. (9.7 mm) [6/16].
 Length of shortest brush at 500 smh is 1.437 in. (36.50 mm) [1-7/16].
 Amount of brush wear at 500 smh is .063 in. (1.60 mm) [1/16].
 or
 $\frac{1}{6}$ of the available brush wear
 $500 \div \frac{1}{6} = 3000$ hrs. total brush wear. (500 hrs. is $\frac{1}{6}$ of 3000 hrs.).

6. The smh estimate of brush life can be used if the machine is to work at the same rate (duty cycle), the battery is not discharged too much or the battery cells have not become damaged. If the machine is made to work harder, the battery is discharged too much, or the battery cells become damaged, the motor temperature will get hot very fast. This will cause rapid wear of the brushes.
7. It is important then to check brush length and condition at a specific time, such as during the preventive maintenance check, and in no more time than every 1000 smh. If an inspection shows that brush life will not extend to the next preventive maintenance check, install new brushes.
8. For additional information about brushes and motors, make reference to the LIFT TRUCK TECHNICAL BULLETIN dated December 21, 1977.

C

DIFFERENTIAL ADJUSTMENTS

Use the 1P67 Spreader (or Owatonna Tool Co. part number 7071 Spreader), 1P2390 Pinion Depth Gauge, and 8S2328 Dial Indicator Group to make adjustments to the differential. A 5P982 Stand and 2P8338 Bracket can be used to hold the differential while the adjustments are made. Follow these steps to adjust the differential:

SHIM THICKNESS FOR DIFFERENTIAL BEARINGS

1. Assemble the differential pinions, side gears, and thrust washers into the differential case.
2. Install pinion shaft with lock pin hole in correct alignment with the hole in the case. Install the lock pin and use a punch to cause a distortion to the metal around the lock pin. This will keep the lock pin in place.
3. Install ring gear (1) on flange (2). Tighten the installation bolts for the ring gear to a torque of 45 to 60 lb. ft. (60 to 80 N·m).
4. Install the differential bearing cones, without shims, on the differential case.
5. Put bearing cups in position on bearing cones, and install differential in housing.
6. Install bearing caps (3). Tighten the bolts just enough to hold bearing cups straight.

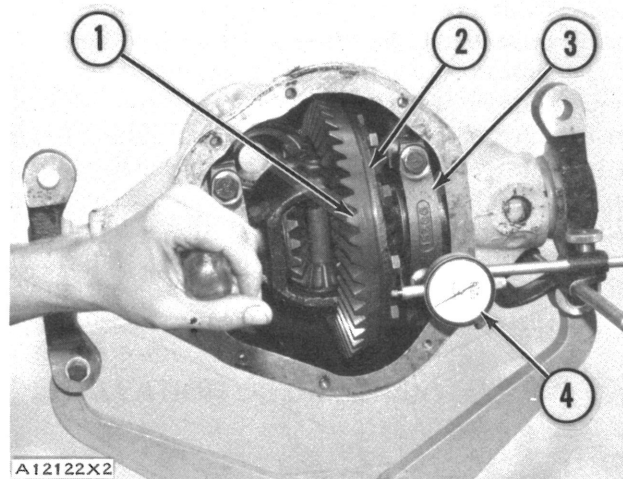
NOTE: Make sure that the marks on bearing caps (3) and housing are in correct alignment.

7. Put the 8S2328 Dial Indicator (4) against the back side of ring gear flange (2).

NOTE: Mark this location on the flange for use in Installation of Differential procedure.

8. Use a screwdriver to move the differential away from dial indicator (4) as far as possible. Adjust the dial indicator to zero while the differential is held in this position.
9. Move the differential in the opposite direction (toward the dial indicator) as far as possible and make a note of the dial indication.

This indication (reading) is the total amount of shims needed when the differential is installed. Part of these shims will be installed on one side of the differential, while the remainder will be installed on the opposite side. The number of shims on each side will be found in the Installation of Differential procedure.



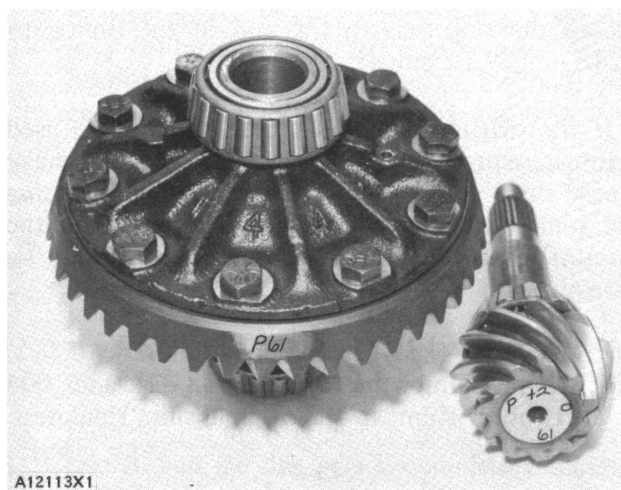
SHIM CHECK FOR DIFFERENTIAL BEARINGS

1. Ring gear. 2. Flange. 3. Bearing caps. 4. 8S2328 Dial Indicator.

10. Remove the differential from the housing. Do not remove the differential bearing cones from the differential case at this time.

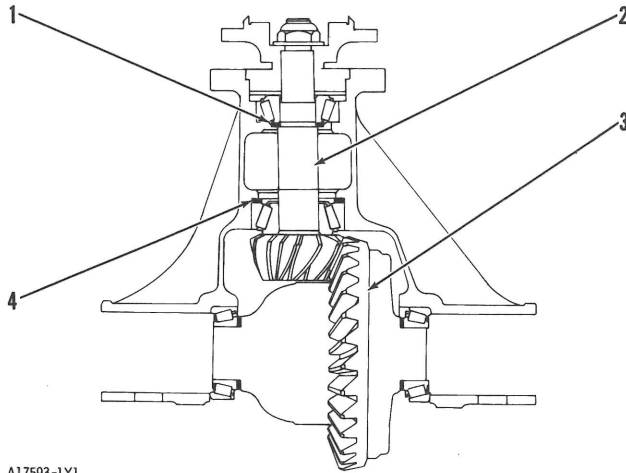
INSTALLATION OF BEVEL PINION

Ring gears and pinions are available in sets that are machined for each other, and must never be installed separately. The same identification mark of letters and numbers is put on both the pinion and the ring gear. Make sure they have the same identification mark before going to the procedure that follows.



IDENTIFICATION MARKS ON RING GEAR AND PINION

The distance from the centerline of the ring gear to the flat end of bevel pinion (2) is 2.25 in. (57.2 mm). The end of each pinion has a mark of either a plus (+) number, a minus (−) number, or zero (0) (if the pinion has a mark of a plus number or a minus number along with a zero [as shown above] use the plus or minus number). These numbers are an indication of the position where each gear set runs best. This dimension is controlled by shim pack (4) behind the inner bearing cup.



A17593-1X1

DIFFERENTIAL

1. Shims (bearing preload). 2. Pinion. 3. Ring gear. 4. Shims (pinion location).

If a pinion has a mark of (+2), it needs .002 in. (0.05 mm) less shims than a pinion with a mark of (0). This increases the distance from the centerline of the ring gear to the end of the pinion to 2.252 in. (57.20 mm). This increase of .002 in. (0.05 mm) is the meaning of a (+2) mark on the pinion. If the pinion has a mark of (−2), it needs .002 in. (0.05 mm) more shims than a pinion with a (0) mark. This reduces the dimension from the centerline of the ring gear to the end of the pinion to 2.248 in. (57.10 mm).

If the original ring and pinion set is to be used again, measure the old pinion shim pack and make a new shim pack to this dimension. If a new ring and pinion set is used, refer to the chart for the amount that the original shim pack should be changed.

EXAMPLE: If the old pinion has a mark of (+2) and the new pinion has a mark of (−2), add .004 in. (0.10 mm) shims to the original shim thickness.

OLD PINION MARKING	NEW PINION MARKING								
	−4	−3	−2	−1	0	+1	+2	+3	+4
+4	+0.008 (0,20mm)	+0.007 (0,17mm)	+0.006 (0,15mm)	+0.005 (0,12mm)	+0.004 (0,10mm)	+0.003 (0,07mm)	+0.002 (0,05mm)	+0.001 (0,02mm)	0
+3	+0.007 (0,17mm)	+0.006 (0,15mm)	+0.005 (0,12mm)	+0.004 (0,10mm)	+0.003 (0,07mm)	+0.002 (0,05mm)	+0.001 (0,02mm)	0	−0.001 (0,02mm)
+2	+0.006 (0,15mm)	+0.005 (0,12mm)	+0.004 (0,10mm)	+0.003 (0,07mm)	+0.002 (0,05mm)	+0.001 (0,02mm)	0	−0.001 (0,02mm)	−0.002 (0,05mm)
+1	+0.005 (0,12mm)	+0.004 (0,10mm)	+0.003 (0,07mm)	+0.002 (0,05mm)	+0.001 (0,02mm)	0	−0.001 (0,02mm)	−0.002 (0,05mm)	−0.003 (0,07mm)
0	+0.004 (0,10mm)	+0.003 (0,07mm)	+0.002 (0,05mm)	+0.001 (0,02mm)	0	−0.001 (0,02mm)	−0.002 (0,05mm)	−0.003 (0,07mm)	−0.004 (0,10mm)
−1	+0.003 (0,07mm)	+0.002 (0,05mm)	+0.001 (0,02mm)	0	−0.001 (0,02mm)	−0.002 (0,05mm)	−0.003 (0,07mm)	−0.004 (0,10mm)	−0.005 (0,12mm)
−2	+0.002 (0,05mm)	+0.001 (0,02mm)	0	−0.001 (0,02mm)	−0.002 (0,05mm)	−0.003 (0,07mm)	−0.004 (0,10mm)	−0.005 (0,12mm)	−0.006 (0,15mm)
−3	+0.001 (0,02mm)	0	−0.001 (0,02mm)	−0.002 (0,05mm)	−0.003 (0,07mm)	−0.004 (0,10mm)	−0.005 (0,12mm)	−0.006 (0,15mm)	−0.007 (0,17mm)
−4	0	−0.001 (0,02mm)	−0.002 (0,05mm)	−0.003 (0,07mm)	−0.004 (0,10mm)	−0.005 (0,12mm)	−0.006 (0,15mm)	−0.007 (0,17mm)	−0.008 (0,20mm)

PINION SHIM CHART

After the correct number of shims are found:

1. Install the baffle, shims (4) and the inner bearing cup into the housing. Install the outer bearing cup into the housing.
2. With the bearing cone installed on pinion (2), install the pinion in the housing.
3. Put the outer bearing cone in place on the pinion shaft. Place the washer on the pinion shaft and install the flange, washer, and nut. Tighten the flange nut until 10 lb. in. (1.1 N·m) of torque is needed to turn pinion (2).

NOTE: The seal and preload shims (1) are not installed at this time because it may be necessary to make additional corrections to pinion location shims (4).

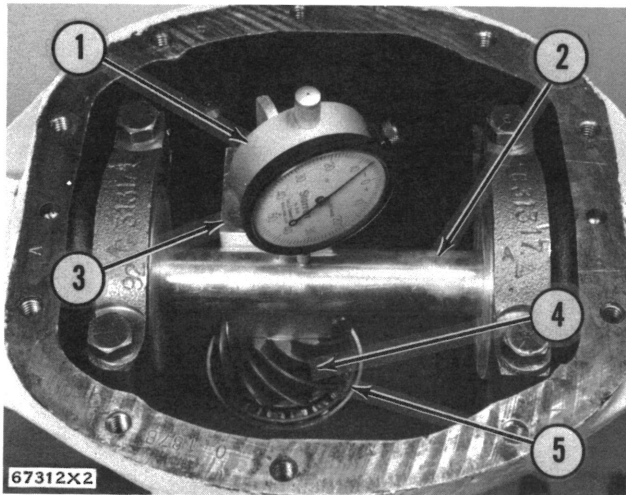
Bevel Pinion Depth Check

After the pinion is installed, use the 1P2390 Depth Gauge with 8S2328 Dial Indicator (1) to check pinion (4) depth adjustment.

1. Put shaft assembly (2) in place as shown. Install bearing caps and bolts. Tighten the bolts just enough to hold the tool straight.

NOTE: Make sure that the marks on the bearing caps and the housing are in correct alignment.

2. Fasten 8S2328 Dial Indicator (1) to the gauge block (3) with the hardware that is with the 1P2390 Depth Gauge.
3. Place the gauge block (3) with dial indicator (1) on the end of the pinion (4).



PINION DEPTH GAUGE

1. 8S2328 Dial Indicator. 2. Shaft assembly (part of 1P2390 Depth Gauge). 3. Gauge block (part of 1P2390 Depth Gauge). 4. Pinion. 5. Inner bearing cup.

4. Do these procedures as follows:
 - a. Adjust the dial indicator to zero on top of gauge block (3).
 - b. Move (turn) the dial indicator until the stem point is on the center (highest point) of shaft assembly (2).
 - c. Take note of the indication on the dial as it is moved on the shaft assembly. The indication must be within .002 in. (0.05 mm) of the number on the end of pinion (4).

NOTE: Make sure that the hardware used to fasten dial indicator (1) to gauge block (3) is tightened completely.

5. If the indication is not correct, shims must be added or removed from behind inner bearing cup (5). To increase the value of the dial indication, remove shims from behind bearing cup (5). Shims must be added to decrease the value of the indication.

Bearing Preload Check for Bevel Pinion

To check the pinion preload:

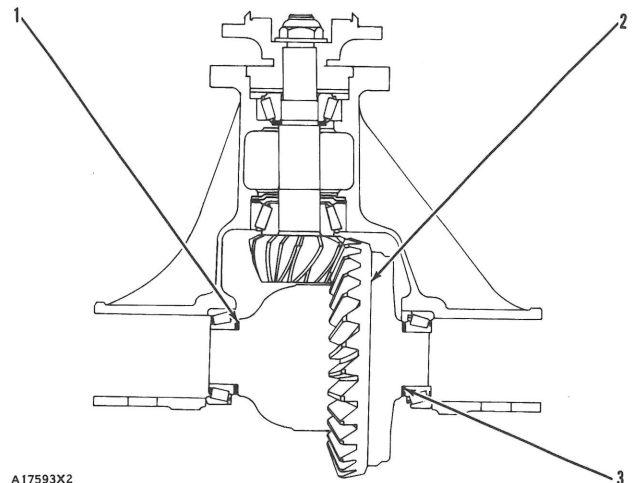
1. Remove the flange from the pinion shaft. Remove the outer bearing cone from the pinion shaft. Put the original thickness of preload shims in place and install bearing cone on shaft again.
2. Install the input flange, washer, and nut. Tighten the nut to a torque of 200 to 220 lb. ft. (270 to 295 N·m).
3. Place a torque wrench on the nut of the input pinion. Turn the pinion and read the indication of the torque wrench.

4. The torque needed to turn the pinion must be 20 to 40 lb. in. (2.3 to 4.5 N·m). If an adjustment is necessary, add or remove shims under the pinion outer bearing cone.

NOTE: If the torque indication is too high, add shims under the pinion outer bearing cone. If the torque is too low, remove shims.

5. When the adjustment is complete, remove the flange and install the seal. After the seal is in place install the flange again and tighten the nut to a torque of 200 to 220 lb. ft. (270 to 295 N·m).

INSTALLATION OF DIFFERENTIAL



DIFFERENTIAL

1. Shim pack. 2. Ring gear. 3. Shim pack.

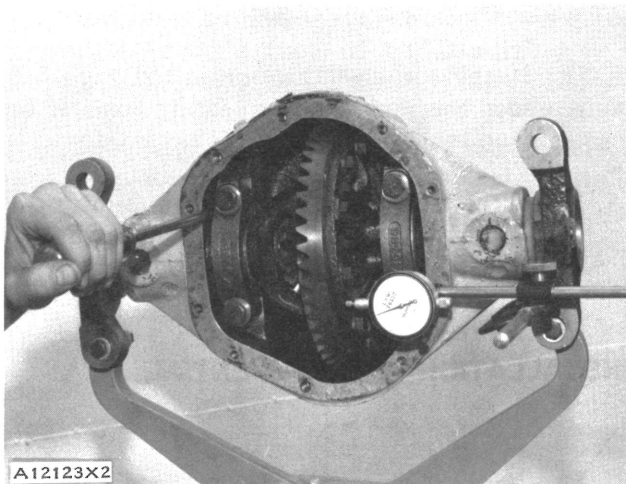
To find the number of shims to be installed on each side of the differential:

1. Put the differential bearing cups in place on the differential. There must be no shims behind the bearing cones. Place the differential, with ring gear (2) installed, into the axle housing. Install bearing caps and bolts. Tighten the bolts just enough to keep the bearing cups straight.

NOTE: Make sure that the marks on the bearing caps and housing are in correct alignment.

2. Mount the 8S2328 Dial Indicator with the stem point against the back side of the ring gear flange. Locate the dial indicator at the mark that was made in Shim Thickness for Differential Bearings procedure.
3. Push against the bearing cup and move the differential until the ring gear is completely engaged with the pinion. Move the ring gear forward and backward until ring gear and pinion are completely engaged. Hold the differential in this position and adjust the dial indicator to zero.

4. Push on the opposite side of the differential to move the differential toward the dial indicator.

**DIFFERENTIAL SHIM CHECK**

5. Read the indication on the dial. This indication is the total amount of shims (3) required behind the ring gear.

NOTE: A note was made of the total amount of shims required for both sides of the differential (see Shim Thickness for Differential Bearings). Subtract the amount of shims (3) needed, from the total shims required as noted before. Add .015 in. (0.38 mm) to this remainder; this total is the thickness of shims (1) required. The extra .015 in. (0.38 mm) of shims gives a bearing preload.

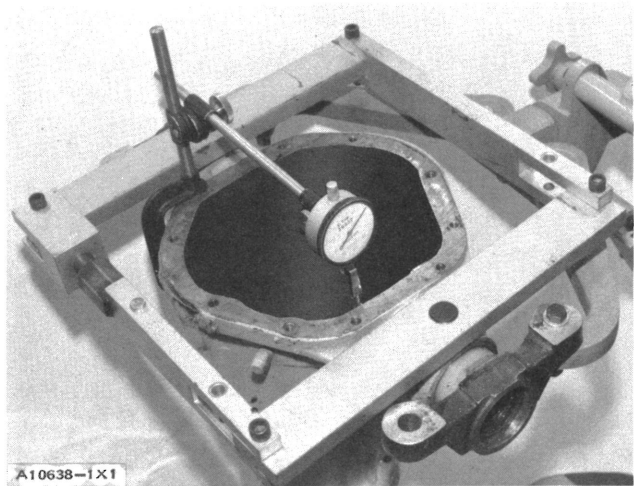
EXAMPLE: If the total distance moved was .070 in. (1.78 mm) (See Shim Thickness for Differential Bearings) and in step 5 an indication of .038 in. (0.97 mm) was read, the .038 in. (0.97 mm) shims must be added on the side of the differential behind the ring gear (shim pack [3]). The remainder of the shims, .032 in. (0.81 mm) thick, plus .015 in. (0.38 mm) (or .047 in. [1.19 mm] total) must be installed on the side of the differential next to the face of the ring gear (shim pack [1]).

6. Remove the differential and install the shims to the proper side of the differential. Install the bearing cones and cups.
7. Use the 1P67 Spreader to cause a distortion to the housing.

NOTE: The maximum distortion of the housing is .020 in. (0.51 mm).

CAUTION

The maximum distortion of the housing is .020 in. (0.51 mm). More than this dimension will cause damage to the housing.

**DIFFERENTIAL INSTALLATION**

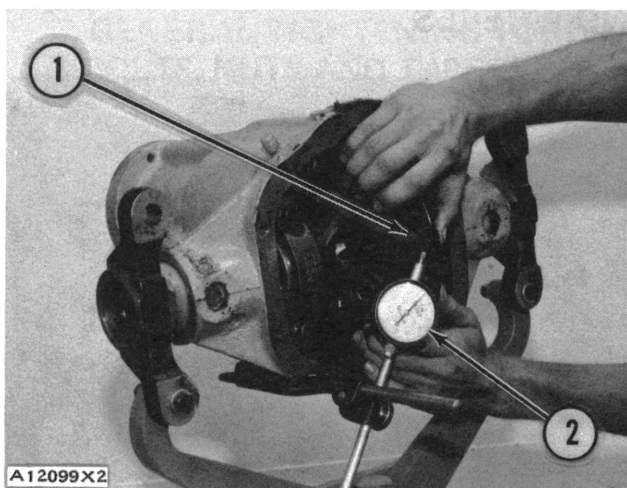
8. Remove the dial indicator and install the differential into the housing. Make sure that the differential is installed completely, and that the gears are engaged properly, then remove the spreader.
9. Install the bearing caps and bolts. Tighten the bolts to a torque of 35 to 50 lb. ft. (45 to 70 N·m).

NOTE: Make sure that the marks on the bearing caps and the housing are in correct alignment.

GEAR CLEARANCE (BACKLASH) ADJUSTMENT

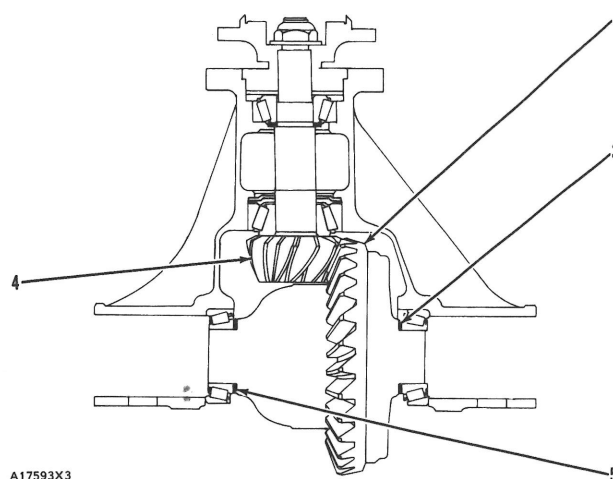
Check the ring gear and the bevel pinion clearance (backlash) at three points around ring gear (1). There must be an equal space between each point.

1. Put indicator (2) on the case and hold the end yoke so that it will not turn.
2. Move ring gear (1) backward and forward while the indication is read. The gear clearance (backlash) must be .005 to .009 in. (0.13 to 0.23 mm) and must not change more than .003 in. (0.07 mm) between the three points. A change of more than .003 in. (0.07 mm) between the three points is an indication of dirt or metal between the ring gear and the case, or a bent flange on the case.

**GEAR CLEARANCE (BACKLASH) CHECK**

1. Ring gear. 2. 8S2328 Dial Indicator.

3. To adjust the gear clearance (backlash), ring gear (1) must be moved toward or away from bevel pinion (4).

**DIFFERENTIAL**

1. Ring gear. 3. Shim pack. 4. Bevel pinion. 5. Shim pack.

NOTE: If the indication shows extra gear clearance (backlash), remove shims from shim pack (5) and add them to shim pack (3). This moves ring gear (1) toward bevel pinion (4). If there is not enough clearance the ring gear (1) must be moved away from bevel pinion (4) by the removal of shims from shim pack (3) and the addition of these shims to shim pack (5).

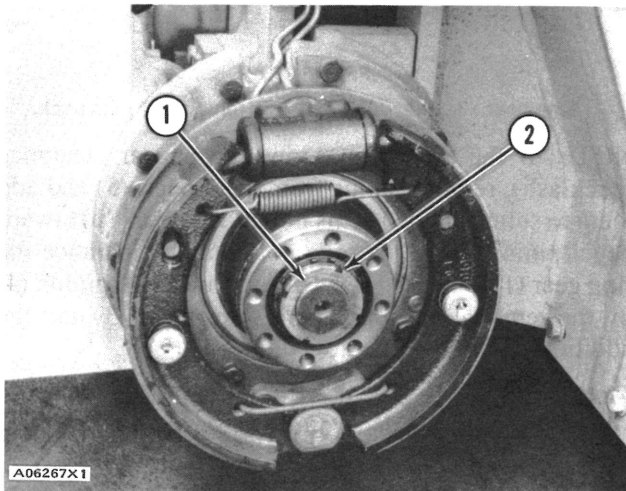
FINAL DRIVE AND WHEELS

C WHEEL BEARING ADJUSTMENT

1. Tighten nut (1) slowly to 100 lb. ft. (135 N·m) while the hub is turned to put the bearing into place.

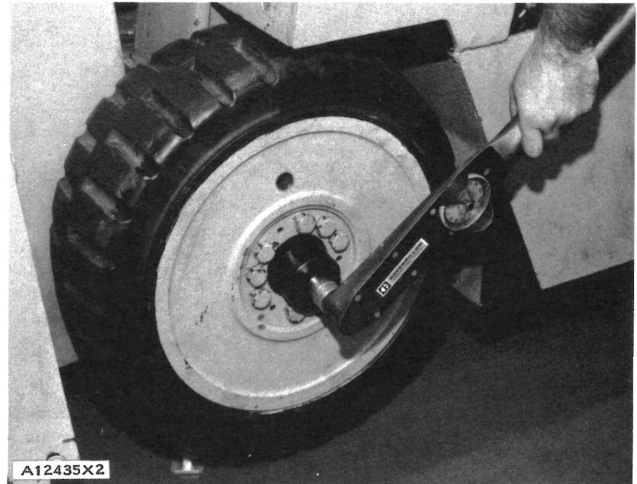
NOTE: Install the drive wheel so hub can be turned easily.

2. Loosen nut (1) completely and tighten again to 20 to 50 lb. ft. (25 to 70 N·m).



BEARING ADJUSTMENT

1. Nut. 2. Lock.



WHEEL BEARING ADJUSTMENT

3. If necessary, loosen nut (1) so lock (2) can be put into position.

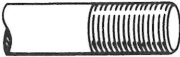
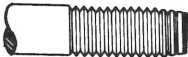
NOTE: If lock (2) cannot be put into position in the range of 0 to 50 lb. ft. (0 to 70 N·m), increase the torque until nut (1) can be locked.

4. Tighten drive wheel bolts to a torque of:
3/8 in. bolts 50 ± 5 lb. ft. (70 ± 7 N·m)
1/2 in. bolts 110 ± 15 lb. ft. (150 ± 20 N·m)

GENERAL TIGHTENING TORQUE FOR BOLTS, NUTS AND TAPERLOCK STUDS

The following charts give the standard torque values for bolts, nuts and taperlock studs of SAE Grade 5 or better quality. Exceptions are given in other sections of the Service Manual where needed.

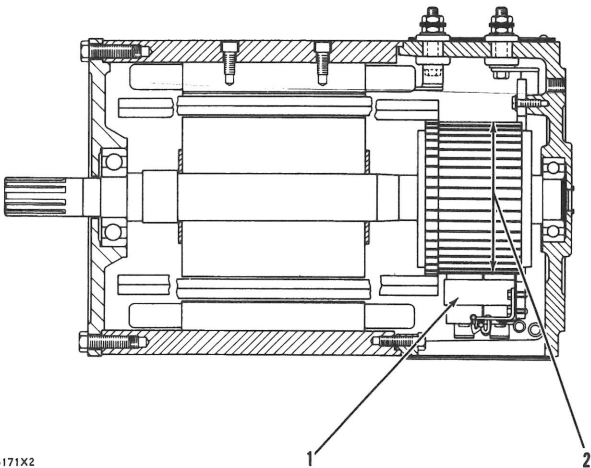


THREAD DIAMETER		STANDARD TORQUE	
inches	millimeters	lb. ft.	N·m*
Standard thread 		Use these torques for bolts and nuts with standard threads (conversions are approximate).	
1/4	6.35	9 ± 3	12 ± 4
5/16	7.94	18 ± 5	25 ± 7
3/8	9.53	32 ± 5	45 ± 7
7/16	11.11	50 ± 10	70 ± 15
1/2	12.70	75 ± 10	100 ± 15
9/16	14.29	110 ± 15	150 ± 20
5/8	15.88	150 ± 20	200 ± 25
3/4	19.05	265 ± 35	360 ± 50
7/8	22.23	420 ± 60	570 ± 80
1	25.40	640 ± 80	875 ± 100
1 1/8	28.58	800 ± 100	1100 ± 150
1 1/4	31.75	1000 ± 120	1350 ± 175
1 3/8	34.93	1200 ± 150	1600 ± 200
1 1/2	38.10	1500 ± 200	2000 ± 275
Use these torques for bolts and nuts on hydraulic valve bodies.			
5/16	7.94	13 ± 2	20 ± 3
3/8	9.53	24 ± 2	35 ± 3
7/16	11.11	39 ± 2	50 ± 3
1/2	12.70	60 ± 3	80 ± 4
5/8	15.88	118 ± 4	160 ± 6
Taperlock stud 		Use these torques for studs with Taperlock threads.	
1/4	6.35	5 ± 2	7 ± 3
5/16	7.94	10 ± 3	15 ± 5
3/8	9.53	20 ± 3	30 ± 5
7/16	11.11	30 ± 5	40 ± 10
1/2	12.70	40 ± 5	55 ± 10
9/16	14.29	60 ± 10	80 ± 15
5/8	15.88	75 ± 10	100 ± 15
3/4	19.05	110 ± 15	150 ± 20
7/8	22.23	170 ± 20	230 ± 30
1	25.40	260 ± 30	350 ± 40
1 1/8	28.58	320 ± 30	400 ± 40
1 1/4	31.75	400 ± 40	550 ± 50
1 3/8	34.93	480 ± 40	650 ± 50
1 1/2	38.10	550 ± 50	750 ± 70

*1 newton meter (N·m) is approximately the same as 0.1 mkg.

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C ELECTRIC DRIVE MOTOR

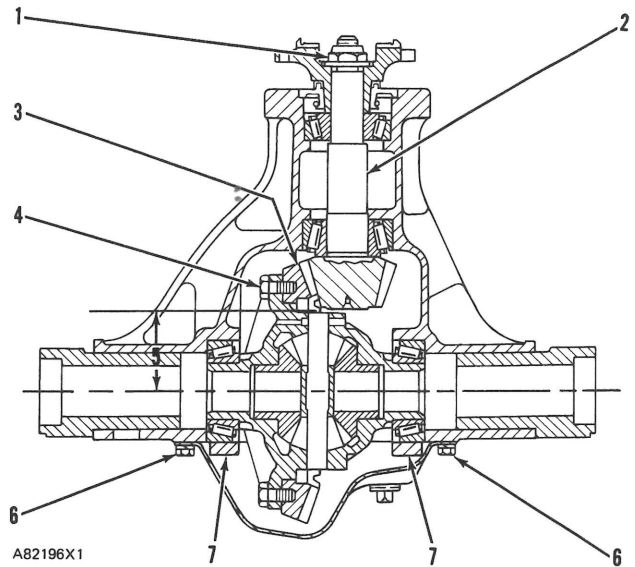


- (1) Motor brushes (new):
- Length of longest side 1.50 in. (38.1 mm)
 - Minimum length measured on the longest side 1.12 in. (28.5 mm)
 - Depth..... .50 in. (12.7 mm)
 - Width..... 1.00 in. (25.4 mm)
- (2) Motor commutator:
- New O.D. 4.461 to 4.466 in. (113.31 to 113.44 mm)
 - Minimum O.D. after rebuild 4.22 in. (107.2 mm)
- NOTE: Remove all rough edges (burrs) after the commutator is machined.
- (3) Machine chamfer on the commutator bars (not shown) 016 in. (0.40 mm)
- (4) The depth (undercut depth) of the mica insulation below the top surface of the commutator bars (not shown)..... .04 in. (1.0 mm)
- (5) The width (undercut width) between commutator bars (not shown)..... .03 in. (0.8 mm)
- (6) Total indicated runout (TIR) of commutator (not shown) 001 in. (0.02 mm)
- (7) Maximum bar to bar runout of commutator (not shown) 0002 in. (0.005 mm)

DIFFERENTIAL

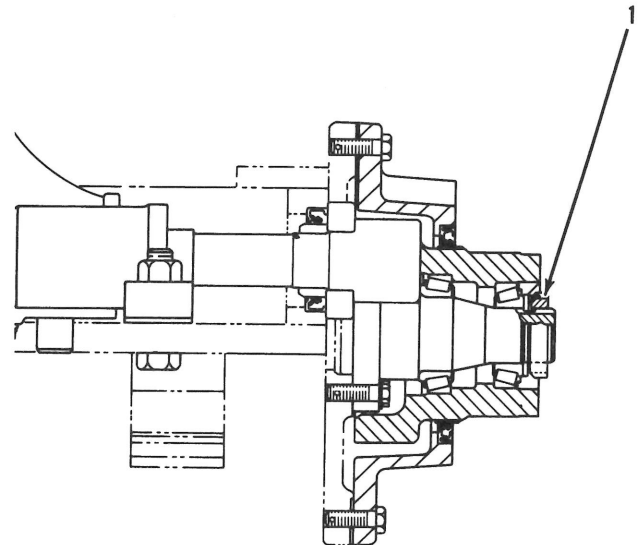
- (1) Torque for the pinion shaft nut 200 to 220 lb. ft. (270 to 295 N $\pm$ m)
- (2) Torque needed to turn the pinion shaft with a preload on the pinion bearings and without the differential installed.
 New bearings 20 to 40 lb. in. (2.3 to 4.5 N $\pm$ m)
 Old bearings 15 to 25 lb. in. (1.7 to 2.8 N $\pm$ m)
 (See Installation of Bevel Pinion in TESTING AND ADJUSTING)
- (3) Amount of gear clearance (backlash) between the ring gear and the pinion 005 to .009 in. (0.13 to 0.23 mm)
 [See Gear Clearance (Backlash) Adjustment in TESTING AND ADJUSTING]
- (4) Torque for the bolts that hold the ring gear to the case 45 to 60 lb. ft. (60 to 80 N·m)
- (5) The distance from the centerline of ring gear to the flat end of the pinion 2.250 in. (57.15 mm)
 (See Installation of Bevel Pinion in TESTING AND ADJUSTING)
- (6) Torque for the bolts that hold the cover to the housing 15 to 25 lb. ft. (20 to 35 N $\pm$ m)
- (7) Torque for the bolts that hold the bearing caps to the housing 35 to 50 lb. ft. (45 to 70 N $\pm$ m)

NOTE: The marks on the bearing caps and housing must be in correct alignment.



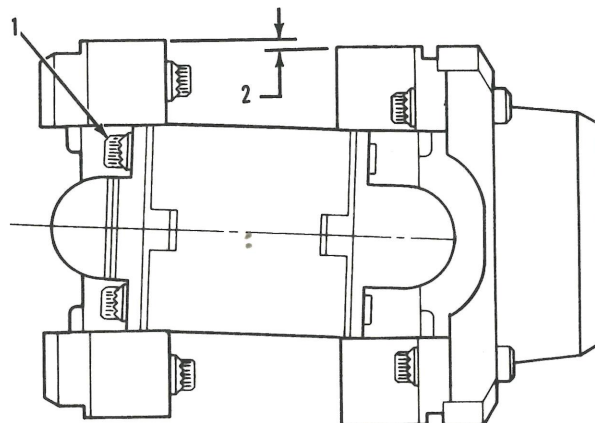
Maximum distortion of the differential housing with the use of a Carrier Spreader Assembly 020 in. (0.50 mm)

FINAL DRIVE AND WHEELS



- (1) Torque for nut that holds the hub on the spindle 20 to 50 lb. ft. (25 to 70 N·m)
 Last torque (after alignment of the lock) 0 to 50 lb. ft. (0 to 70 N·m)

C

UNIVERSAL JOINT

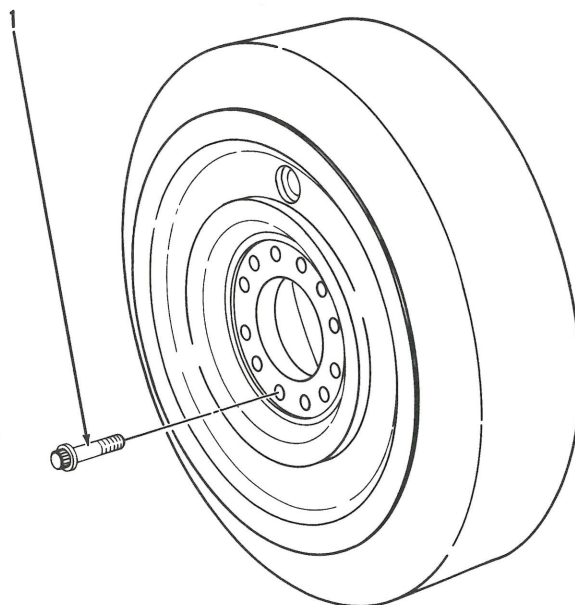
A16661X1

(1) Torque for universal joint bolts 25 ± 3 lb. ft. (35 ± 4 N·m)

(2) Maximum amount that universal joint
can be out of alignment 03 in. (0.8 mm)

NOTE: Measure the gap at two locations 90° apart. Add or remove shims under drive motor to put the universal joint in correct alignment.

C

DRIVE WHEEL INSTALLATION

A16687X1

(1) Torque for bolts that hold drive wheel to hub:

3/8 in. bolts 50 ± 5 lb. ft. (70 ± 7 N·m)

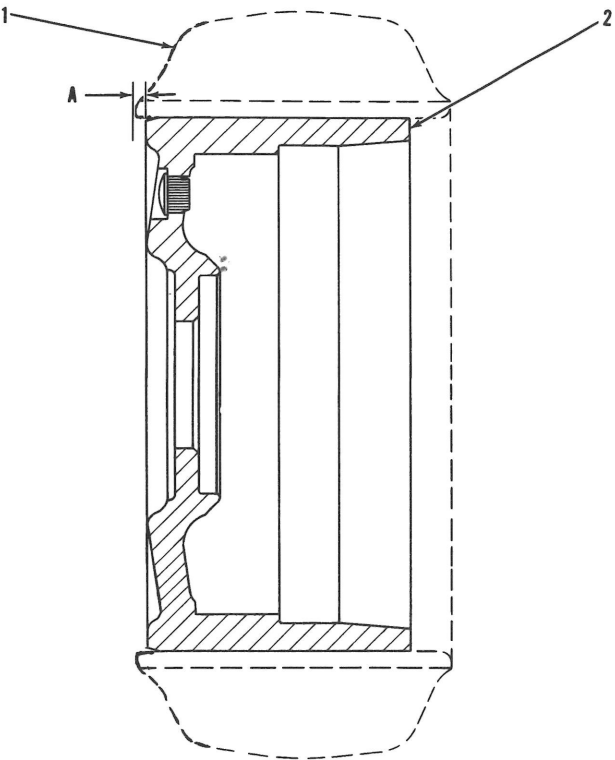
1/2 in. bolts 110 ± 15 lb. ft. (150 ± 20 N·m)

NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

DRIVE TIRE INSTALLATION

 WARNING

When there is a tire replacement for a worn tire, new tire (1) must be installed so outer edge of tire is .12 in. (3.05 mm) (A) from wheel (2). If it is not, the lift truck stability will be decreased.



A51682-1X1

Dimension A is 12 in. (3.05 mm)



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